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| 10/692,608 | 10/24/2003 | Robert Snee Gilmore | 124574-1 | 8806 |

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GENERAL ELECTRIC COMPANY
GLOBAL RESEARCH
PATENT DOCKET RM. BLDG. K1-4A59
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| EXAMINER | |
|---|---|
| MILLER, ROSE MARY | |

| ART UNIT | PAPER NUMBER |
|---|---|
| 2856 | |

DATE MAILED: 05/05/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

SM

| Office Action Summary | Application No. | Applicant(s) | |
|---|---|---|---|
| | 10/692,608 | GILMORE ET AL. | |
| | Examiner | Art Unit | |
| | Rose M. Miller | 2856 | |

*-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

**Period for Reply**

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

**Status**

1)☒ Responsive to communication(s) filed on *22 March 2004 and 17 March 2005*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

**Disposition of Claims**

4)☒ Claim(s) *1-31* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-3,11-13,18-24 and 28-31* is/are rejected.

7)☒ Claim(s) *4-10,14-17 and 25-27* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

**Application Papers**

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *24 October 2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

**Priority under 35 U.S.C. § 119**

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

**Attachment(s)**

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date *3/22/04 & 3/17/05*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

## DETAILED ACTION

### *Specification*

1. The disclosure is objected to because of the following informalities: the equation presented on the top of page 7 of the specification is incorrect. If one substitutes $2\pi f_o/c$ for $k$ on the left side of the equation, one does not obtain the result depicted on the right side of the equation. As this appears to be a typographical error, the specification is only being objected to for minor errors at this time. However, if Applicant indicates that this is not a typographical error, the Examiner reserves the right utilize Section 112 in the next office action to clarify the issues concerning this equation.

Appropriate correction is required.

### *Claim Rejections - 35 USC § 112*

2. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

3. Claims 3, 13, and 24 rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 3, 13, and 24 are rejected as being confusing and indefinite. As with the equation recited in the specification, the equation on the right side of the equal sign is not obtained when the expression $2\pi f_o/c$ is substituted for $k$ in the equation on the left side of the equal sign. Therefore, it cannot be determined at this time how $\beta$ is determined from the equation cited. Correction is necessary to fully determine the scope of the invention as claimed.

### *Claim Rejections - 35 USC § 102*

4. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

5. Claims 1, 11, 20, 22, and 30 are rejected under 35 U.S.C. 102(b) as being anticipated by **Bolorforosh et al. (US 6,132,377)**.

With regards to claim 1, **Bolorforosh et al.** discloses insonifying an object (tissue) with ultrasonic energy at a selected fundamental frequency; acquiring amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency; and generating a non-linear acoustic image from said amplitude data at said fundamental frequency and said second harmonic frequency (see Figure 4). As for determining incipient mechanical failure of an object as recited in the preamble of the claim, this is merely intended use as the body of the claim does not support such a determination and it is therefore given little or no patentable weight.

With regards to claim 11, **Bolorforosh et al.** discloses insonifying the object (tissue) with ultrasonic energy at a selected fundamental frequency using a backscatter scan; focusing a broadband transducer so as to detect amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency; digitizing and storing said amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency (inherent in use of system of Figure 2); and generating a non-linear acoustic image from said amplitude data at said fundamental frequency and said second harmonic frequency (see Figure 4). As for determining incipient mechanical failure of an object as recited in the preamble of the claim, this is merely intended use as the body of the claim does not support such a determination and it is therefore given little or no patentable weight.

With regards to claim 20, **Bolorforosh et al.** discloses utilizing two bandpass filters (21, 22), one centered around the fundamental frequency and one centered around the second harmonic of the fundamental frequency (see column 3 lines 39-48).

With regards to claim 22, **Bolorforosh et al.** discloses a broadband transducer (16) for insonifying the object (tissue) with ultrasonic energy at a selected fundamental

frequency using a backscatter scan; said broadband transducer focused so as to detect amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency; a pulser receiver (20) for receiving detected signals from said transducer; and a data acquisition computer for storing said amplitude data at said fundamental frequency and a second harmonic of said fundamental frequency in a digitized format (inherent in use of system of Figure 2); wherein said stored amplitude data at said fundamental frequency and said second harmonic frequency is used to generate a non-linear acoustic image (see Figures 2 and 4). As for the system determining incipient mechanical failure of an object as recited in the preamble of the claim, this is merely intended use as the body of the claim does not support such a determination and it is therefore given little or no patentable weight.

With regards to claim 30, **Bolorforosh et al.** discloses utilizing two bandpass filters (21, 22), one centered around the fundamental frequency and one centered around the second harmonic of the fundamental frequency (see column 3 lines 39-48).

### *Claim Rejections - 35 USC § 103*

6. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

7. This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

8. Claims 1-3, 11-13, 20-25, 30 and 31 are rejected under 35 U.S.C. 103(a) as being unpatentable over **"REAL-TIME MONITORING OF ACOUSTIC LINEAR AND NONLINEAR BEHAVIOR OF TITANIUM ALLOYS DURING CYCLIC LOADING"** by **Frouin et al.** (hereafter referred to as **Frouin et al.**) in view of **Bolorforosh et al.**

**Frouin et al.** discloses a method for determining incipient mechanical failure of an object comprising: insonifying the object with ultrasonic energy at a selected fundamental frequency, acquiring amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency, and determining the acoustic nonlinearity of the object from the amplitude data at said fundamental frequency and said second harmonic of said fundamental frequency.

**Frouin et al.** discloses the claimed invention with the exception of generating a non-linear acoustic image from said amplitude data at said fundamental frequency and said second harmonic frequency.

**Bolorforosh et al.** teaches utilizing a measured acoustic nonlinearity (a ratio of the amplitude of the second harmonic frequency to the amplitude of the fundamental harmonic) to generate an improved acoustical image of the subject under test.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the testing system of **Frouin et al.** with the capabilities to generate a non-linear acoustic image of the object under test as taught by **Bolorforosh et al.** in order to produce a more accurate representation of the object under test and the life remaining within the test object.

With regards to claim 2, **Frouin et al.** clearly teaches that the acoustic nonlinearity of the object under test is generated by using a ratio of the amplitude data at said second harmonic frequency and the square of said amplitude data at said fundamental frequency.

With regards to claim 3, **Frouin et al.** clearly teaches the acoustic nonlinearity being equal to $\left(\frac{8}{ak^2}\right)\left(\frac{A_2}{A_1^2}\right)$ where $A_2$ is the amplitude of the second harmonic frequency

($2f_0$), $A_1$ is the amplitude of the fundamental frequency ($f_0$), k is the ultrasonic wave number (which inherently equals $2\pi f_0/c$, wherein c is the velocity of the acoustic signals in the material of the object), and *a* is a scanning parameter (length of sample).

With regards to claim 11, **Frouin et al.** discloses a method for determining incipient mechanical failure of an object comprising: insonifying the object with ultrasonic energy at a selected fundamental frequency, focusing a broadband transducer so as to detect amplitude data from the insonified object at said fundamental frequency and a second harmonic of said fundamental frequency, digitizing and storing said amplitude data at said fundamental frequency and the second harmonic frequency (inherent in the computer) and determining the acoustic nonlinearity of the object from the amplitude data at said fundamental frequency and said second harmonic of said fundamental frequency.

**Frouin et al.** discloses the claimed invention with the exception of using at least one of a backscatter scan and a surface wave scan to insonify the object and generating a non-linear acoustic image from said amplitude data at said fundamental frequency and said second harmonic frequency.

**Bolorforosh et al.** teaches utilizing backscatter scan to determine an acoustic nonlinearity (a ratio of the amplitude of the second harmonic frequency to the amplitude of the fundamental harmonic) in order to generate an improved acoustical image of the subject under test.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the testing system of **Frouin et al.** with the backscatter scan capabilities of **Bolorforosh et al.** in order to generate a non-linear acoustic image of the object under test as taught by **Bolorforosh et al.** so as to produce a more accurate representation of the object under test and the life remaining within the test object.

With regards to claim 12, **Frouin et al.** clearly teaches that the acoustic nonlinearity of the object under test is generated by using a ratio of the amplitude data at said second harmonic frequency and the square of said amplitude data at said fundamental frequency.

With regards to claim 13, **Frouin et al.** clearly teaches the acoustic nonlinearity being equal to $\left(\frac{8}{ak^2}\right)\left(\frac{A_2}{A_1^2}\right)$ where $A_2$ is the amplitude of the second harmonic frequency ($2f_0$), $A_1$ is the amplitude of the fundamental frequency ($f_0$), k is the ultrasonic wave number (which inherently equals $2\pi f_0/c$, wherein c is the velocity of the acoustic signals in the material of the object), and *a* is a scanning parameter (length of sample).

With regards to claim 20, **Frouin et al.** and **Bolorforosh et al.** both disclose utilizing two bandpass filters, one centered around the fundamental frequency and one centered around the second harmonic of the fundamental frequency.

With regards to claim 21, **Frouin et al.** discloses using waveform-analysis software (custom developed software) for determining the acoustic nonlinearity of the object.

With regards to claim 22, **Frouin et al.** discloses a system for determining incipient mechanical failure of an object comprising: a transducer for insonifying the object with ultrasonic energy at a selected fundamental frequency, said transducer focused so as to detect amplitude data from the insonified object at said fundamental frequency and a second transducer for detecting the amplitude data of a second harmonic of said fundamental frequency, a pulser receiver for receiving detected signals from said transducer, and a data acquisition computer for storing said amplitude data at said fundamental frequency and said second harmonic of said fundamental frequency in a digitized format; wherein said stored amplitude data at said fundamental frequency and said second harmonic frequency is used in determining the acoustic nonlinearity of the object.

**Frouin et al.** discloses the claimed invention with the exception of the transducer specifically comprising a broadband transducer, the transducer receiving amplitude data both for the fundamental frequency and the second harmonic frequency and generating a non-linear acoustic image from said amplitude data at said fundamental frequency and said second harmonic frequency.

**Bolorforosh et al.** teaches utilizing a pulse-echo transducer to both transmit the fundamental frequency to insonify the object under test and to receive the amplitude data for both the fundamental frequency and the second harmonic frequency and to utilize the measured acoustic nonlinearity (a ratio of the amplitude of the second harmonic frequency to the amplitude of the fundamental harmonic) to generate an improved acoustical image of the subject under test.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the testing system of **Frouin et al.** with the capabilities of the system of **Bolorforosh et al.,** and to include the pulse-echo transducer of **Bolorforosh et al.,** so as to generate a non-linear acoustic image of the object under test as taught by **Bolorforosh et al.** in order to produce a more accurate representation of the object under test and the life remaining within the test object.

With regards to claim 23, **Frouin et al.** clearly teaches that the acoustic nonlinearity of the object under test is generated by using a ratio of the amplitude data at said second harmonic frequency and the square of said amplitude data at said fundamental frequency.

With regards to claim 24, **Frouin et al.** clearly teaches the acoustic nonlinearity being equal to $\left(\frac{8}{ak^2}\right)\left(\frac{A_2}{A_1^2}\right)$ where $A_2$ is the amplitude of the second harmonic frequency ($2f_0$), $A_1$ is the amplitude of the fundamental frequency ($f_0$), k is the ultrasonic wave number (which inherently equals $2\pi f_0/c$, wherein c is the velocity of the acoustic signals in the material of the object), and *a* is a scanning parameter (length of sample).

With regards to claim 30, both **Frouin et al.** and **Bolorforosh et al.** disclose utilizing two bandpass filters, one centered around the fundamental frequency and one centered around the second harmonic of the fundamental frequency wherein the outputs of the bandpass filters are converted to digitized format for storage in the computer.

With regards to claim 31, **Frouin et al.** discloses using waveform-analysis software (custom developed software) for determining the acoustic nonlinearity of the object.

9. Claims 18-19 and 28-29 rejected under 35 U.S.C. 103(a) as being unpatentable over **Frouin et al.** in view of **Bolorforosh et al.** as applied to claims 11 and 22, respectively, above, and further in view of **Morris et al. (US 4,265,120)**.

With regards to claims 18 and 28, **Frouin et al.** in view of **Bolorforosh et al.** discloses the claimed invention with the exception of a surface scan being performed and the transducer being focused so as to include the Rayleigh wave critical angle of the insonified material. **Morris et al.** teaches utilizing the second harmonic signal of a surface acoustic wave to determine the fatigue (and therefore remaining life) of an object under test. It is inherent in the use of a surface scan that the Rayleigh wave critical angle is included in the focus of the transducer used as without such an angle there would not be any generation of surface acoustic waves. Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to utilize a surface scan, and therefore include the Rayleigh critical angle in the focus of the transducer, in the system of **Frouin et al.** as utilizing such to determine the fatigue of an object is taught by **Morris et al.**

With regards to claims 19 and 29, it would have been obvious to one of ordinary skill in the art to focus the transducer so as to isolate a surface wave from a direct reflection wave as it is well known throughout the art of ultrasonic measuring and testing that the different types of waves can interfere with one another and produce erroneous test results. Therefore, one of ordinary skill in the art would know to separate the different forms of ultrasonic waves in order to produce a more accurate test result.

### *Allowable Subject Matter*

10. Claims 4-10, 14-17 and 25-27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

***Conclusion***

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

**Guracar et al. (WO 98/46139)** discloses ultrasound imaging enhancement method and systems.

**Matsumura (US 2002/0009204 A1)** discloses a signal processing method and apparatus and imaging system.

**Rielly et al. (US 2004/0064043 A1)** discloses a continuous depth harmonic imaging system using transmitted and nonlinear generated second harmonics.

**Migita (US 2004/0077947 A1)** discloses an ultrasonic diagnostic apparatus and ultrasonic diagnostic method.

12. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rose M. Miller whose telephone number is 571-272-2199. The examiner can normally be reached on Monday - Friday, 7:30 am to 3:30 pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Hezron Williams can be reached on 571-272-2208. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

RMM
29 April 2005

HEZRON WILLIAMS
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